Space Weather Technical Forecast

Issued on Monday, 28 March 2022 at 01:15 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Declining risk of G1/Minor Storm intervals Days 1 & 2 (28-29 Mar). Chance of M-class flares throughout. Slight chance of Active fluence by Days 3 & 4 (30-31 Mar).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low with several minor C-flares. There are currently five sunspot regions on the visible disc. AR2975 has developed significantly recently, and is now showing a magnetically complex setup although with no significant flares as yet. AR2978 is currently difficult to classify due to its proximity to the southeast limb. The largest region is AR2976 in the northeast quadrant. AR2977 to the northwest of AR2975 has continued to show some slow development through the last 12 hours. The much smaller spot AR2974 (which produced an M1 flare on 25th) is now small, simple and inactive.
No Earth directed CMEs have been observed in the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind as observed by DSCOVR at L1 indicated the arrival of a positive coronal hole high speed stream, likely CH69/+. Wind speeds were initially between 400 and 450 km/s, but rose from 27/0500 UTC to vary between 480-550 km/s. The density has been mostly above average (up to 20 ppcc). The strength of the IMF, Bt, has been at weak to moderate levels, peaking at 15nT at 27/0640 UTC. The north-south component, Bz, varied between +13/-11 nT. The Phi angle was predominately positive (away from the Sun), but with brief transitions to negative. Geomagnetic activity was Quiet to Active (Kp 2-4).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) measured at GOES 16 was at Background levels. The high energy electron flux (greater than 2MeV) has also been at Background levels. The 24-hour integrated electron fluence was well below the Active (1e8 integrated pfu) threshold on a declining trend, with the observed fluence at 28/0000 UTC 1.05e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low, with further C-class flares expected. There is a chance of activity increasing to Moderate levels, with isolated M-class flares. The recent rapid development of AR2975 and a better view of AR2978 when it's more fully on the disc may cause these probabilities to be revised.

Solar Wind / Geomagnetic Activity: A CME which left the Sun on 25th may give a glancing blow at Earth early on Day 1 (28 Mar). Solar wind speeds are currently elevated, due to the high speed stream from CH69/+. They are expected to remain elevated through Day 1 (28 Mar), slowly easing through Day 2 (29 Mar) as the coronal hole effects wane.
Quiet to Active conditions are expected during Days 1 and 2, with G1/Minor Storm intervals possible from the potential CME arrival. Geomagnetic activity is expected to become predominantly Quiet during Day 2 and continue through Day 4 (31 Mar).

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to be at Background levels throughout the forecast period. However, there is a slightly

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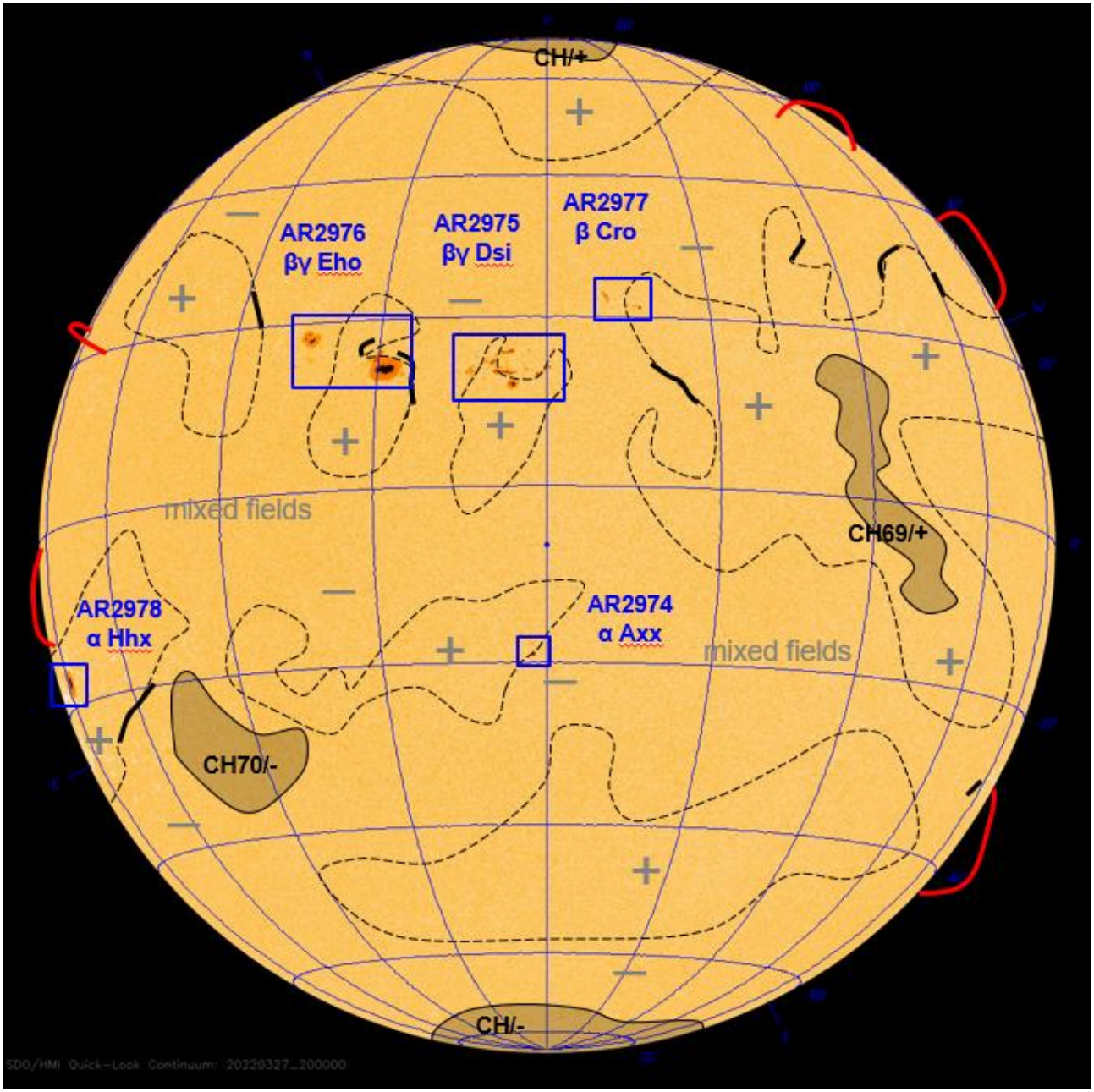
raised risk of a radiation storm due to the recent significant development of AR2975.
The high energy electron flux is currently at Background levels. As the current HSS wanes and any risk of CME effects passes, then a rising trend in electron flux values is possible through the coming days, perhaps reaching High levels at the diurnal peaks by Days 3 and 4 (30-31 Mar). This is low confidence however. The associated 24 hour fluence may follow an erratic rising trend through the next four days, although levels are likely to remain below the Active (1e8 integrated pfu) threshold.

Figure 1. Solar Analysis Valid 27/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Met Office Space Weather Technical Forecast

Geomagnetic Storms:
There is a CME which has the potential for a glancing impact at Earth, which originated from the M1.5 flare of AR2974 on the 25th. There is some notable uncertainty with the timing of this CME, and extent of impact, due to a difficult assessment on the westward extent of the CME in available imagery. The modelled arrival time is 27/2300 UTC +/- 10 hours.

Solar wind speeds are currently elevated, due to the high speed stream from CH69/+. They are expected to remain elevated through Day 1 (28 Mar), slowly easing through Day 2 (29 Mar) as the coronal hole effects wane. This is in-line with observations at STEREO-A, although any CME effects may keep higher wind speeds for longer during Day 2.

Quiet to Active conditions are expected during Days 1 and 2, with G1/Minor Storm intervals possible from the potential CME arrival. Geomagnetic activity is expected to become predominantly Quiet during Day 2 and continue through Day 4 (31 Mar).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	50	10	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
25/1225	Full halo	M flare	12S 20E	560	27/2300 UTC +/- 10 hrs	Glancing blow likely

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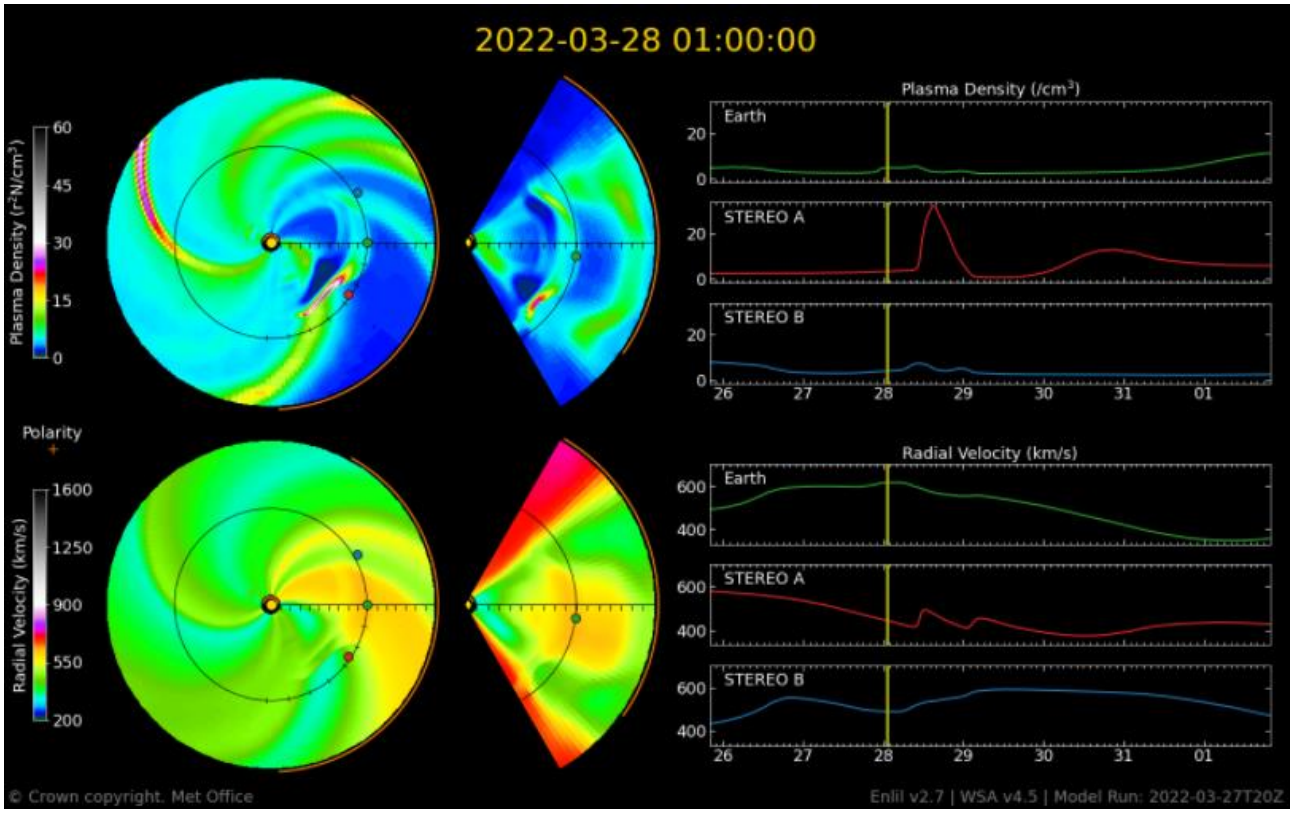
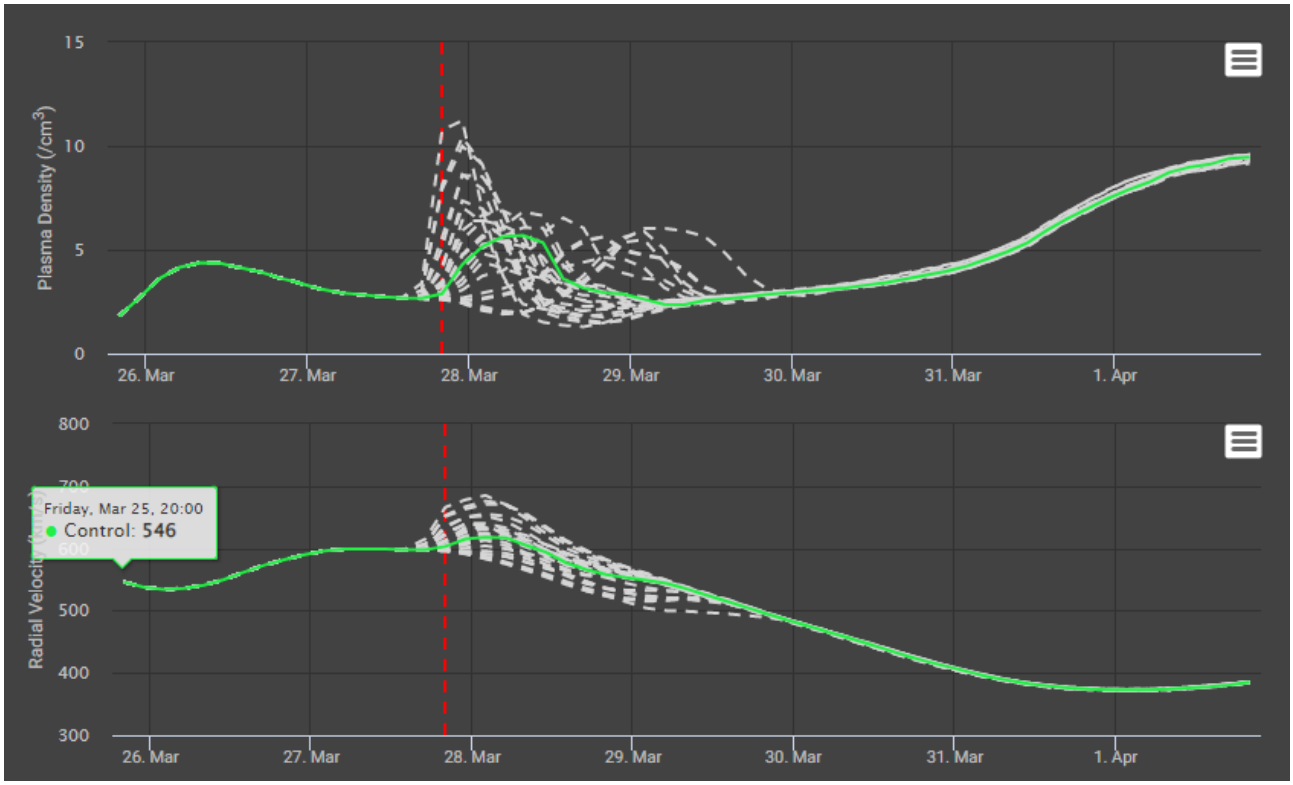
Figure 2: Enlil and ensemble showing a possible CME glancing blow in the early hours of 28th March.





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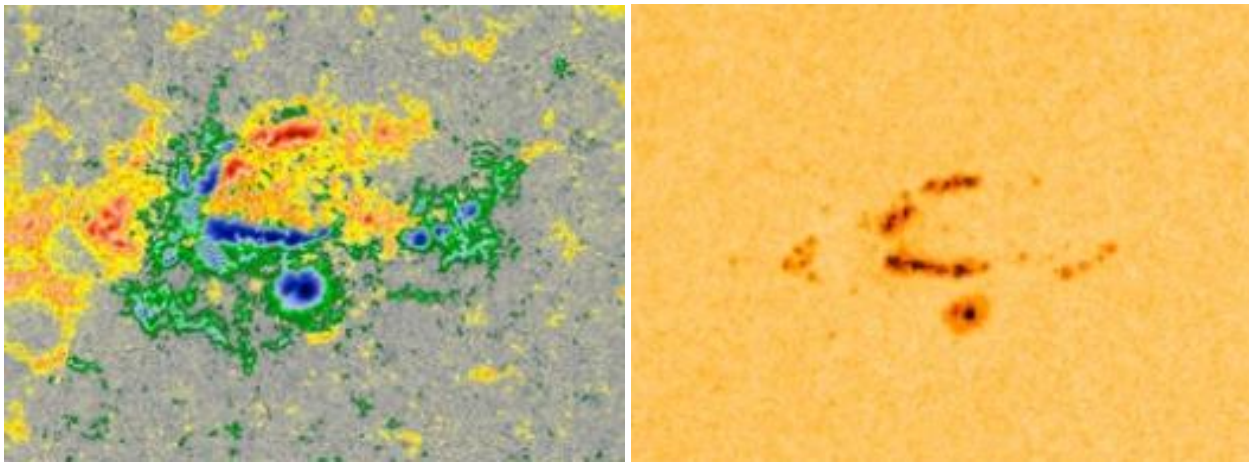
Radio Blackouts - X-Ray Flares:
Solar activity is currently Low. AR2975 (recently re-classified Dsc/Beta-Gamma-Delta) has developed quite rapidly recently and has a complex magnetic setup. This region is beginning to look as though it may have potential for larger flares, especially if it continues its development. AR2978 on the southeast limb has given recent minor C-flares. It is difficult to classify due to its proximity to the limb, with a current classification of Hhx/Alpha. However, this could just be the leading spot of a larger group so its flare probabilities may be revised as this becomes more fully visible. AR2976 (Eho/Beta-Gamma) is currently the largest region with some magnetic complexity on the leading spot. AR2977 has developed recently and is currently classified Cro/Beta. AR2974 is a simple Axx/Alpha region.

Activity is expected to be at least Low, with C-class levels expected. There is a chance activity may increase to Moderate levels, with the main M-flare risk coming from AR2975. Flare probabilities will be re-assessed once AR2978 is fully visible and if AR2975 continues to develop.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: SDO magnetogram and intensitygram imagery of AR2975, showing significant magnetic complexity after recent development.



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Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (10MeV) measured at GOES-16 is expected to remain at Background levels. However, there is a slightly raised risk of a radiation storm due to the recent significant development of AR2975. This has increased the probability of a larger flare occurring, which gives the risk of raised proton levels.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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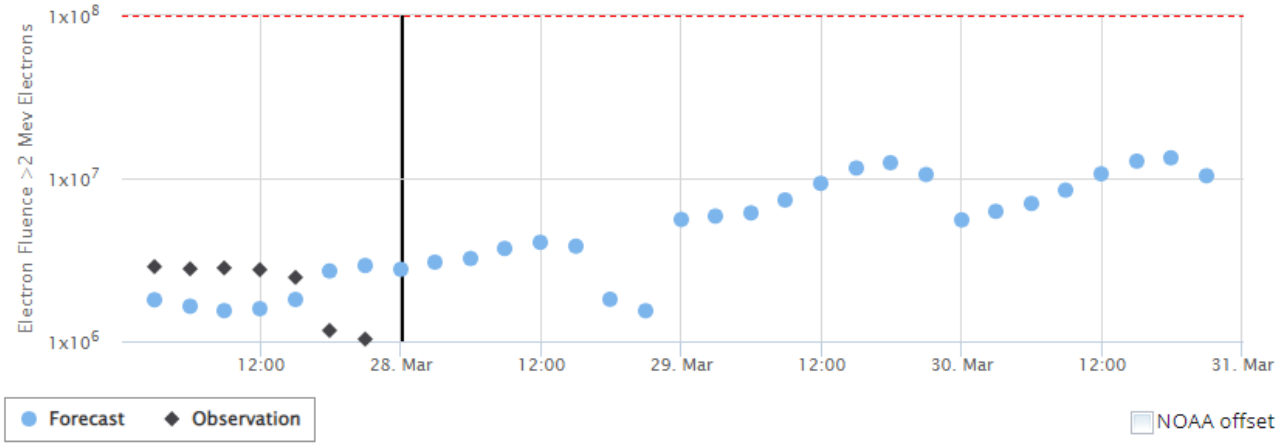
High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux as observed by GOES-16 at GEO is currently at Background levels, but may rise once the high speed stream from CH69 starts to wane. This is further complicated by a possible CME arrival early Day 1 (28 Mar), likely causing flux values to remain suppressed at first. Once this has passed, then a rising trend in electron flux values is possible through the coming days, perhaps reaching High levels at the diurnal peaks by Days 3 and 4 (30-31 Mar). That said, there was little electron response to this feature on the last rotation, although there was a later response to a second HSS. However, this second feature is no longer present on the disc.

The associated 24 hour fluence may follow an erratic rising trend through the next four days, although levels are likely to remain below the Active (1e8 integrated pfu) threshold. REFM is considered to be giving reasonable guidance at the present time, showing a rising trend peaking below Active levels.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	5	10	20	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: REFM forecast, which is considered to be giving generally good guidance at present.



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